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ABSTRACT

In adult numeracy instruction, the gap between current and potential instructional realities is of great concern. Narrowing that gap might best be accomplished with creative, sly, and surprising combinations of practice, research, theory, and/or policy. This paper describes current policies, practices, and research connected with adult numeracy instruction in the United States, proposes a different model, and depicts three multi-dimensional interventions which create powerful opportunities to find the way from what currently exists to what might be. (Contains 30 references.) (Author/MM)

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by
Mary Jane Schmitt

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Seeking Interventions to Improve Adult Numeracy Instruction in the United States: Hybrids Only Need Apply

Mary Jane Schmitt
TERC
<mary_jane_schmitt@terc.edu>

In adult numeracy instruction, the gap between current and potential instructional realities is of great concern. Narrowing that gap might best be accomplished with creative, sly, and surprising combinations of practice, research, theory, and/or policy. In this paper, I describe current policies, practices, and research connected with adult numeracy instruction in the United States, propose a different model, and depict three multi-dimensional interventions which create powerful opportunities to find the way from what currently exists to what might be.

An estimated 90 million adults in the United States demonstrate skills that are less than adequate to meet the demands of a technological society (Kirsch, Jungeblut, Jenkins, & Kolstad, 1993). My work and this paper focus on a subset of that population - the approximately 4 million adults who enrol in publicly funded adult basic education programs in the United States each year.

According to one analysis, the reasons for participation in adult basic education programs can be categorised as follows: accessing information, giving voice to one's ideas, acting more independently, and keeping up with a rapidly changing world (Stein, 1995). Whatever an adult's reasons for participating, their return to school typically includes reading, writing, and mathematics instruction (Beder, 1999). Participants in adult basic education programs are mostly poor and female. Many of them are immigrants seeking to improve their command of English. Some participants want to improve their employment prospects. About a third are young adults who have dropped out of formal education and may enrol in order to pass a high school equivalency exam.[1]

Adult basic education programs in the United States are operated locally by a variety of organisations and agencies. Adult students attend approximately two to twenty hours of instruction a week in classes run by school systems, community colleges, workplaces, libraries, correctional institutions, shelters, or community-based organisations. Program staff members are usually employed on a part-time or volunteer basis. One out of seven is a professional adult basic education teacher working on a full-time basis (United States Department of Education, 1999).

This segment of the population, in these non-traditional educational contexts, should pique the interest of educational researchers in the literacy, language, and mathematics fields - even those researchers whose primary focus is the education of children or university students. Alan Bishop has wisely observed:

> Adults are not like school students but they too are mathematics learners. So we can expect to find from research on adult learners, data and thoughts which will inform and extend our constructs and concepts of mathematics learning in general (Bishop, 1997, p.3).

[1] 1997-1998 data as reported on the United States Department of Education website: http://www.ed.gov/offices/OVAE/datahome.html.

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The Current Status of Adult Numeracy in the United States

While mathematics education reform has been at the forefront of K-12 school reform in the United States (with leaders, resources, curriculum, and staff development aimed at implementing the principles and standards articulated by the National Council of Teachers of Mathematics and supported by research), the topic of numeracy education is almost non-existent in the national debate concerning adult basic education reform. In adult numeracy instruction, the gap between current and potential instructional realities is disturbing with an increasingly wider gap between K-12's teaching of mathematics and adult basic education's approach. Below I describe the current backdrop for adult numeracy instruction in the United States, propose a different model, and depict three multi-dimensional interventions which create powerful opportunities to narrow the gap between existing practices and the promises of reform mathematics.

Current Numeracy Policy

Literacy - the ability to read and write - is accepted by policymakers as an essential goal in adult education and training while numeracy - the ability to work with quantity, space, and relationships - is ignored. For more than a decade, advocates for adult basic education have lobbied hard to make sure that literacy becomes a national priority. The success of their efforts is evident in the titles of major organizational structures created in the 1990s: the National Center for the Study of Adult Learning and Literacy, the National Institute for Literacy, and the Division of Adult Education and Literacy (which prior to 1991 was named the Division of Adult Education).

While some policymakers insist that numeracy has been included under the literacy umbrella, numeracy is nearly absent from the mission statements and reports of the aforementioned institutions. Despite the minimal attention that numeracy receives in policy circles and public debate in the United States, some analysts estimate that more than 80% of adults enrolled in adult basic education programs receive some math-related instruction (Gal & Schuh, 1994). Where mathematics is expressly referenced, such as within the new accountability system, a limited view of numeracy as arithmetic procedures prevails. The nature and content of math-related instruction provided to adult basic education students should be of critical importance to math reformers and researchers as well as policymakers and funders who care about adults' ability to participate in society and to perform on math-related tasks in everyday life.

Current Curriculum Model

At present, the two forces that mould adult basic education mathematics curriculum are the high school equivalency exam (i.e. the GED) and commercially published workbooks. While the workbooks are *de facto* curriculum guides for teachers, the GED exam is the key motivator for teaching mathematics. "Is this going to be on the GED?" is the adult student's equivalent of her high school counterpart's question: "When are we ever going to use this?" In their genuine desire to respond to students and in their quest for outcomes, teachers are pressured to gear their classes to the GED.

The GED consists mainly of multiple-choice items presented in adult-like contexts. The mathematics questions of the GED are divided among four areas: (a) number operations and number sense; (b) measurement and geometry; (c) data analysis, statistics, and probability; and (d) algebra, functions, and patterns (GED Testing Service, 2001).

Commercial workbooks reflect these categories and generally present computational routines, with opportunities for repeated practice of these routines in direct preparation for the test.

In the future, adult numeracy curriculum may be primarily shaped by the National Reporting System (NRS), a national assessment system developed by the United States Department of Education. The potential danger of this system is that curriculum will be geared predominantly to commercial standardised tests. Thus, the goals of adult students who want to address the mathematical demands of their daily life, to prepare for further education, or to train for specific employment purposes may be overshadowed by the need to demonstrate high standardised test scores.

The Adult Numeracy Teachers and their Pedagogy

Most adult education teachers are trained in the fields of literacy or language. Fewer than 5% of adult education teachers in the United States are certified as mathematics specialists or instructors (Gal and Schuh, 1994). Surveys indicate, however, that literacy teachers often have to teach mathematics as well. For example, the majority of adult basic education teachers in Arkansas teach all subjects, including mathematics, but most of them have a bachelor's degree in elementary education (Ward, 2000). Similarly, a significant percent of adult basic education teachers in Massachusetts became math instructors either "by accident" or because it was a requisite of their employment (Mullinix, 1994).

Individualised instruction and repeated practice are the staple of mathematics instruction. Teachers commonly use individualised instruction for several reasons. First, certain factors of the adult basic education environment, specifically multi-levelled classes and irregular attendance, warrant such instruction. Second, teachers want to avoid embarrassing moments that could discourage students by awakening unpleasant memories of past educational experiences. Further, they want to respond to the students' stated goals. Thus, many teachers believe that each student should follow an individualised program. Whether it take the form of a folder with a checklist of pages to complete or computer-assisted instruction, individualised instruction results in a classroom culture defined by isolated silence.

A hallmark of individualised instruction is the reliance on repeated practice of routine procedures outlined in workbooks (Kloosterman, Hassan, & Wiest, 2000). However, when used as the primary tool for mathematics instruction, workbooks often "discourage intuitive approaches and promote a mathematics that comes from an outside authority rather than a personal mathematics that can be applied in many situations" (Tout & Schmitt, 2002, p. 162).

Research on Numeracy

Research on numeracy in adult basic education is minimal. Further, the research that does exist focuses mainly on affective issues, such as math anxiety, rather than cognitive issues (Safford-Ramus, 2000). Some limited attempts, however, have been made to promote research related to adult numeracy in the United States. For example, the National Center on Adult Literacy (NCAL) published technical reports that lay out the need for a research program on adult numeracy (Gal, 1993; Gal and Schmitt, 1994). Further, the National Center for the Study of Adult Learning and Literacy (NCSALL) coordinated with international research efforts by hosting a research forum on adults learning mathematics in

July 2000 (ALM7 Conference). To date, however, there is no coordinated research program being conducted.

Proposed Improvements to Adult Numeracy Instruction

This bleak profile of American adult numeracy education must change. While adult basic education is viewed as a second chance for so many people who have dropped out of the educational system as children, this second chance need not be second rate. Adults returning to education deserve quality experiences that reward their courageous and arduous efforts.

An Improved Numeracy Policy

In contrast to literacy campaigns in the United States that have omitted numeracy, similar campaigns for adult access to basic education in other English-speaking countries, such as the United Kingdom and Australia, speak of an adult *literacy and numeracy* educational system. The differences in policy go beyond the name as well, the United States might do well to emulate these models.

The strength of the Australian model is its numeracy standards that are based on a contextual definition of numeracy. The most widely adopted approach is the Certificates in General Education for Adults (Kindler, Kenrick, Marr, Tout, & Wignall, 1996). This nationally accredited, competency-based curriculum framework takes the view that numeracy is about making meaning of mathematics and has developed a set of learning outcomes that are organised around the purpose and use of mathematics in social contexts: numeracy for practical purposes, numeracy for interpreting society, numeracy for personal organization, and numeracy for knowledge.

The United Kingdom offers standards, which provide a richer mathematics for all levels. In the United States, only number computation is targeted for those at the beginning level, whereas the British standards include geometry and data topics at all. An improved national policy in adult education would, like in Australia and the United Kingdom, include numeracy and contextualise and enrich topics to be covered at all levels.

An Improved Numeracy Curriculum

Adult basic education mathematics instruction should be less concerned with school mathematics and more concerned with the mathematical demands of the everyday world, namely the demands that adults face in their roles as workers, family members, and community members. Thus, numeracy curriculum should not be synonymous with school mathematics but emerge as a new discipline linking mathematics with the real world. Johnston and Yasukawa (2001) have come to believe the focus is on the link itself:

> In our teaching of numeracy … it is *the relationship, the negotiation*, between mathematics and the world that has become the core concern (p. 292).

As opposed to remedial basic mathematics, the subject matter of this new curriculum might be defined as an "at homeness"[2] with quantity, space, and relationships. An ideal

[2] In 1982 , Cockcroft used the phrase "at homeness with number" to describe what it means to be numerate. (Cockcroft Report, 1982, paragraph 39).

numeracy curriculum might follow the tenets proposed by the Adult Literacy and Life Skills Survey:

> Numerate behavior is observed when people manage a situation or solve a problem in a real context; it involves responding to information about mathematical ideas that may be represented in a range of ways; it requires the activation of a range of enabling knowledge, behaviors, and processes (Gal, van Groenestijn, Manly, Schmitt, and Tout, 1999, p. 11).

Math content areas–number, data, algebra, and geometry–would be integrated at all levels of progress and with all relevant contexts, for people who are at the beginning levels of literacy as well as those readying for further education.

An Improved Pedagogy of Numeracy

The pedagogy of numeracy appropriates the best of approaches from K-12, but aligns itself with the principles of andragogy, namely respect for adults' experiences in the workforce/world. In practice, we think this would look something like this:

> Students in our classrooms work in small groups, interacting, puzzling over problems, strategizing about solutions, sharing these solutions with other groups in the class, and listening to others' solutions and strategies. As they collaborate, students 'talk math.' Their discourse includes mathematical vocabulary and explanations of how they have solved a problem and why the solution makes sense. The teacher acts as a facilitator, to guide the learning and to make the mathematics explicit ... In the classrooms where we are trying to develop communities of mathematical investigation and discourse, we hear students' ideas and understandings that we had not heard before. (Steinback, Schmitt, Merson & Leonelli, in press).

Ginsburg and Gal's (2001) suggested instructional strategies concur with the spirit of what we consider a healthy instructional environment: opportunities for explorations, group work, and the sharing of multiple strategies. This vision is further bolstered by Susan Imel (1999) who has suggested that established adult education principles be used to redesign programs. Such principles include involving learners in planning and implementing learning activities; drawing on their experiences as a resource; and encouraging self-direction along with spirit of collaboration.

Improved Training for Adult Numeracy Teachers

It is not realistic to require a pre-service program for the adult basic education system, but it is feasible to provide ongoing opportunities for teacher development. Communities of teachers working together to improve both content and pedagogical knowledge should be the norm, rather than the exception. The reflective practitioner described by Shön (1983), one who learns and responds *in situ,* is preferable to one who comes armed with all the knowledge she needs. The tools of the classroom - the curriculum, the pedagogy, the instruction, the discourse, and the assessments - should be seen as supporting not only the every student's learning, but every teacher's learning as well. The following section on multiple interventions fills out this picture in a bit more detail.

An Improved Research Model for Adult Numeracy

A research program that would inform practice and policy and build theory should focus on adults' numerate thinking in and out of classroom settings. The research on the development of children's mathematical thinking and the body of work on everyday cognition can serve as starting points, but a separate line of research should focus on adults

learning mathematics. In 1994, British adult numeracy practitioners and researchers convened Adults Learning Maths - A Research Forum. This group has extended internationally and serve as a site for sharing and building a research program. In the following section, I outline one way I hope the main research enterprise on adult mathematical thinking might occur.

Multi-dimensional Interventions

Clearly, those who want to see a first-rate education available for adults need to be catalysts for change with stamina to face tremendous obstacles. Given numeracy's stepchild status within an already marginalised field, the need to be creative and sly, maximising existing resources leads us to consider surprising combination of practice, research, theory, and/or policy. Below I depict three multi-dimensional interventions that create powerful opportunities to find the way from what currently exists to what might be.

Where Practitioners Become Researchers

I first got an inkling about how powerful a hybrid intervention could be when a teacher group became researchers. From 1992-1994, sixteen of us came together and formed what became known as the Massachusetts Adult Basic Education Math Team. We taught math in adult basic education centres across our small state, Massachusetts. Some taught GED preparation, others beginning literacy/numeracy; and some taught English to speakers of other languages (ESOL) or to workers in industrial workplace education programs. These distinctions soon blurred as we created and embarked upon a two-year collaborative teacher-research project to test and adapt the NCTM *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989) to our adult basic education classrooms.

As researchers, we posed questions that challenged one aspect our current teaching approaches. These questions were often rhetorical, but they provided focus. For example,

- Can (my) fear of manipulatives be overcome?

> I sincerely hope that no longer will the tools for teaching math be considered a book, a pencil, a paper, and an assignment to do the next 20 problems and check your answers in the back. After doing this project I now realize why so many people do not like math. Who would like trying to rearrange numbers with absolutely no concept as to what they are doing? (Richards, 1994, p. 10).

- What happens to students' definitions of math and science as they explore the connections between them through an integrated unit approach?

> [Describing the class being taped for a video] Under bright lights with cameras in our faces we were scaling down the Solar System, the Milky Way, and the distances within. Calculators were buzzing, zeros were flying, and mistakes were being made comfortably.In the video, I had really faded into the distance (DeCoster, 1994, p 26).

We were on alert for changes in our students' attitudes, but also ended up uncovering what had not been obvious before about what adults in our classes were thinking. Consider this striking example - one teacher's account of how learners left their numerate selves at the door of the classroom:

> I asked a group of my GED math students to tell me how much it would cost if I bought four shirts for $7.98 each. They were told they could figure it out anyway they wanted, except they could not use paper and pencil. I watched as they used their fingers in the air or "wrote" on the desk. Most were able to multiply and get the right answer. When I asked HOW they got their answer, all agreed that they needed to multiply $7.98 by four.

> I then asked if they were in a store and had to figure out the same problem would they have done it the same way. All agreed they probably would NOT solve it the same way in "real life." Some said they would have multiplied four by seven plus four by one and then subtracted eight cents from that total. Others said they would have rounded $7.98 to $8.00, multiplied that by four and then subtracted $.08 from the product. I then asked why no one admitted to solving the problem like that in class. The response was that this was math class they need to do it qut. (Moses, 1994, p. 60).

The teachers' research questions and ensuing reflections re-aligned instruction with the highest principles espoused by adult education theorists and NCTM: teacher as facilitator and co-learner rather than know-it-all, and the importance of meaningful mathematics rather than rote learning. The contradictions we had all grown accustomed to and lived with were no longer willingly tolerated compromises in our heads or classrooms.

Team members saw this as transformative on several levels. The changes played out in the ways they taught, what they taught, how they approached doing mathematics themselves, the ways their students approached doing mathematics, their approach to teaching other subjects, and the ways they looked at their workplaces and at themselves professionally and personally. In the mid-project evaluation, one member was quoted as saying, "It's been sort of a religious experience for me to be on this math team. I've changed so much ... I know I've only just started" (Francis, 1993, p. 4).

In retrospect, at the root of the transformative experience that many math team participants describe is the powerful combination of agency/activism on so many fronts. Teachers were at once researchers, learners, leaders and advocates. They felt overwhelmed at times, but also powerful. Revisiting the stories of their transformations is useful. It gives us hope and it provides us with a successful model to replicate. However, not every project can be a math team. Nor should it. As discussed above, the issues are located at the policy level and within the curriculum as well as at the level of staffing: teacher approach, background, and math competence. While Massachusetts math team teachers made reform mathematics come alive in their classrooms and took a message about reform into frameworks and workshops, at the state level, I dreamed that we could make that much more change happen by building a national community of adult numeracy educators and by infiltrating curriculum. To the degree that any of these interventions has been successful in changing policy or shaping curriculum, I now ascribe the success to the same causes as the original math team success: the power of activism on multiple fronts.

Where Practitioners Build a National Community and Influence Policy

While the Massachusetts ABE Math Team was meeting, activity was also brewing in other places: at the National Center on Adult Literacy's Numeracy Project, at the Math Exchange Group in New York City, and at the GED Testing Service. Teachers were not only experimenting in their classes; they were talking about it with other practitioners. With funding from the Department of Education and the National Council of Teachers of Mathematics, over 100 practitioners and policymakers came together. At this meeting, the practitioners formed the Adult Numeracy Practitioners Network (now the Adult Numeracy Network or *ANN*). This group has collaborated on a framework for adult numeracy standards (Curry, Schmitt, & Waldron, 1996) and continues to serve as a forum for those involved in adult numeracy.

An open question for ANN is where and how best to make its presence known. Pockets of reform are wonderful, but do not affect the majority of adults in the adult basic education system. Where are the most effective points for leverage? Is it within K-12

organizations to gain visibility for adult education, within literacy circles to gain recognition for numeracy? Is it better to go it alone? These are decisions for a group with an eye on the national rather than regional implications. ANN members refuse to be isolated like the learners in individualised classes; they will talk to each other and be heard on a national level.

The EMPower Curriculum Project

Over the past ten years, adult basic education math teachers have built their grass roots networks. Numeracy is somewhat more visible at statewide conferences and in states' curriculum frameworks initiatives. A vibrant root system supports a plant's reach for the sun. To that end, we stretched teachers and asked them to keep firmly planted in their classrooms, but also to dip into policy and research. What would happen if we stretched curriculum beyond its usual job of regulating the time spent in classrooms? What if it is stretched to be a vehicle for staff development and a conduit for research?

At TERC, in Cambridge, Massachusetts, I am part of a team of educators currently developing a curriculum for adults and out-of-school youth. We call it *EMPower - Extending Mathematical Power*[3] because its purpose is to extend the K-12 reforms to adult basic skills programs. Our working hypothesis is that adults will benefit from some of the pedagogical tactics of the reform movement. The *EMPower* Project, too, is a hybrid intervention because it combines curriculum development with research and the curriculum with staff development.

Where Curriculum Is a Tool for Staff Development

The concept of curriculum serving as a vehicle for staff development fits well with the staff of adult education. As mentioned at the beginning, adult education teachers are likely to have little mathematics training. In the ideal world, adult basic education teachers would come to their jobs with some training in mathematics teaching, but unlike K-12 schools, we have no teacher preparation system and no mechanism to reach teachers who typically find employment in adult education accidentally. Even in a best case scenario, where the training was available and programs and staffs could afford to participate, the problem of teacher turnover plagues the field. Writing a curriculum that explicitly takes on the role of staff development is unique for adult education. We have learned about this model from the authors of TERC's K-5 curriculum, *Investigations in Number, Data, and Space* (Mokros, J. & Russell, S.J. 1995). These authors take the stance that teachers form a kind of partnership with the curriculum:

> The link between curriculum and teacher decision-making is a focus on mathematical reasoning. Neither curriculum nor teacher can fully anticipate the complex and idiosyncratic nature of the mathematical thinking that might go on among thirty students in a single classroom during any one mathematics class. However, both teacher and curriculum contribute to a repertoire of knowledge about student thinking that leads to better mathematics teaching and learning (Russell, 1997, p. 248).

When curriculum supports teacher development in this way, aside from the suggested lists of materials, objectives, and steps, it assumes that teachers could benefit from ideas

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[3] Extending Mathematical Power (EMPower) is funded by the National Science Foundation under Grant Number ESI-9911410. The website is http://empower.terc.edu.

for leading mathematics discussions, how to respond to learners' ideas, and what to look for when students are working in small groups on investigations.

To foster students' independent thinking, problem solving, reasoning, and communication, there must be opportunities in class for learners to express their ideas and their logic. Most teachers are accustomed to a format where they ask questions that call for a short answer. Conducting a math discussion requires more than a good question. At least three ingredients are key: an open-ended question, wait time, and a culture of listening. The curriculum can encourage wait time and can describe a classroom culture where learners' strategies are valued, and it is well poised to deliver carefully crafted questions that spark exchange. Within a given lesson, learners are often asked "How did you know?" rather than "What did you get for the answer?" In this way the curriculum helps make the students' mathematical thinking audible and visible, so that the teacher can make decisions about appropriate next steps.

Authentic questions ask for learners' ideas or past experiences where the teachers do not know the answer already. Learners' responses to such questions will often catch teachers off guard. Relating to the question in their own idiosyncratic way, learners may open the door for conversation or math that is only tangentially related to what the teacher had prepared. Teachers often fear such questions and the loss of control of the math in the lesson. Having an inkling of what learners might say helps teachers keep the math on track. One teacher whose students interpreted an investigation about the average price of a used four-door car to mean "which car would be the best car for someone of my means to buy?" asked that the math lessons include a section called "Learners might say." By providing this section, teachers are better able to anticipate and incorporate learners' contributions.

The curriculum encourages teachers and students get behind the meaning of the algorithms, formulae, tricks and short cuts. In order to teach this way, teachers need to be secure in their own understanding. One teacher this year asked for more information about the order of operations. She wondered why multiplication and division precede addition and subtraction. In order to help students appreciate the "why", she herself needed more background information. Most curriculum resources avoid lengthy explanations of content, assuming that teachers will reference other sources for such information. *EMPower* does not make that assumption.

Curriculum Development as Research

Whenever possible, *EMPower*'s lessons are based on existing research. Yet with the little research available on adults' numerate thinking, much of what is written is based on instinct, years of informal observation and experimentation, and research on children's mathematical thinking. When the *EMPower* research plan was originally designed, its purpose was to collect data from classes piloting draft lessons in order to inform the scheduled revisions. We want to know how doable the lessons are, what piques people's interest, what kinds of conceptions arise, and suggestions teachers might offer to strengthen the investigations. We also watch for evidence of teacher and learner attitudinal and behavioral change, including how the class comes together as a community. While these goals remain a central focus of our formative evaluation, the pilot and field-test phases of curriculum development are an opportunity to collect data on adults' mathematical understandings. Over time, our findings will dispute or concur with research on children or ethnographic studies of adults using mathematics in authentic contexts.

What has become interesting to us is the variation of mathematical understandings within and across groups. It is clear that at the same time we collect student work and tapes of classes in order to refine the curriculum, we have a golden opportunity to analyse the data to learn more about adults' mathematical ideas. Given the paucity of research on numeracy in adults, *EMPower* is uniquely situated to contribute to the field. We are determined to not to lose this opportunity and therefore our website is intended to do more than market the curriculum. By including examples of what we have collected, we make moments from our research publicly available. By sharing these examples and commenting on their meaning, we will begin to foster a dialogue about the development of mathematical thinking in adults.

Similarly, our curriculum will include conversations in classes and background on how adults conceptualise. We imagine that a set of understandings and strategies, as seen in written work or heard in classroom conversation, might be included in the curricular materials as examples of how lessons have played out. These data also help us craft suggested rubrics for teachers to look more closely at student work. Examples of what we are learning follow.

Geometry, arrays, and multiplicative thinking. One example of how the curriculum development and research intertwine can be seen in the way a geometry investigation uncovered ways of counting. As veteran teachers, we know that people confuse perimeter and area. Whenever we teach it in our GED classes, students do not differentiate between five inches and five square inches, and area and perimeter formulas are interchanged as well. In the *EMPower* geometry unit, we want to find a way to highlight the distinction between linear and square units. We present learners with a rectangle marked off in square centimetres and ask: "How many square centimetres cover the 5 cm. by 10 cm. rectangle?" Phrased that way, rather than "What is the area, in square centimetres?" the problem becomes one of determining quantity. The question seems to focus attention on what we had hoped, namely the square unit. Most learners arrived at the answer of 50, but the strategies for arriving at that number varied. We observed students:

- Counting each square centimeter, one at a time.
- Counting the number in one row (5) and skip counting by 5's (5, 10, 15 ... 50), or counting the number in one row (10) and skip counting by 10's (10, 20, 30, 40, 50).
- Combining skip counting with some doubling (5, 10, then by two rows at a time ... 20, 30, 40) or (5,10,15, 20, 25) with 25 + 25 making 50.
- Multiplying 5 by 10.

We continued to notice the frequent appearance of this combination of skip counting and doubling. Surprisingly, the array did not signal the operation of multiplication. The strategy of skip counting and doubling persisted as a strategy that made sense. Because we thought that the formula $A = lw$ would make more sense if an l by w array signalled multiplication, we made sure to include opportunities in other investigations to make sense of pictures, such as the number of cars in a neatly arranged parking lot.

From field notes, videotapes, and student work, we are beginning to uncover phenomena that occur during open-ended investigations. We want to pursue and respond to these as we continue to develop the curriculum. We have noticed recurrences such as:

- During investigations on the relationship between the circumferences and diameters of various circles, students examine data suggesting that the circumference measure

is about three times the diameter. For some, this sits uncomfortably beside the idea that the diameter is the line that cuts the circle in half, not thirds. This makes us wonder about what it is that people are focusing on when they compare a table of numbers with the geometric (spatial) information.

- Disagreements as to whether seven 1,000,000s is the same as a million 7s. People's sense of multiplicative commutativity is more fragile than we had anticipated.

- Asked to make a graph from a two-column table of values, some people tended to copy the list of values on the axes as a list of numbers rather than as a number line with a scale.

How to best respond to these phenomena is not always so obvious. How careful should we be not to impose a skill hierarchy, such as the one that we implicitly imposed on how people counted the number of square centimetres? If we do rationalise a hierarchy, how careful should we be not to assume that the range and variation of a skill hierarchy in the population does not necessarily imply that the individual must or will develop according to that hierarchy? Adults who have not been to school in a while may feel quite free to use the bits and pieces of their understanding as resources for thinking about new ideas. And those bits and pieces may jump all over the scope and sequence of school-taught skills.

Conclusion

I come from a small and committed community of adult education teachers deeply concerned with the inequities associated with poverty, inadequate schools, and racism. The mathematics that concerns us are the percentages that the students in our adult education classes are part of: the 40% of the adult population with inadequate skills; the 89% of GED graduates who enrol in Community College who do not complete more than one year; and the persistent achievement gaps between black, Hispanic, and white students. We may not talk about those inequities in our daily work, but they are the phenomena which drive us as we strive to change the face of numeracy instruction from one of remedial isolation to inquiry community, from places where school-based arithmetic algorithms reign to places where the ways in which adults mathematise the world are major resources. Folks come to our classes hopeful to pass tests, but we want them to have bigger hopes than that. They are the reasons we have banded together in teams: the Massachusetts ABE Math Team, the Adult Numeracy Network, and the EMPower team. They are the reasons we search internationally, to our counterparts in Australia, the Netherlands, and the United Kingdom, and the Adults Learning Maths- A Research Forum.

Governments and their education and training systems seem more or less motivated to close the gap between the least numerate and the adequately numerate. In most cases, the interventions to remedy the situation are targeted at the school level and at the university level insofar as the preparation of teachers is concerned. I have spent many years in the classroom as a teacher, another number of years working with teachers, working at the state level, and now as a researcher and curriculum developer. I think we do not have a chance of moving toward the vision unless the interventions we propose are interdisciplinary. Hybrids only need apply.

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